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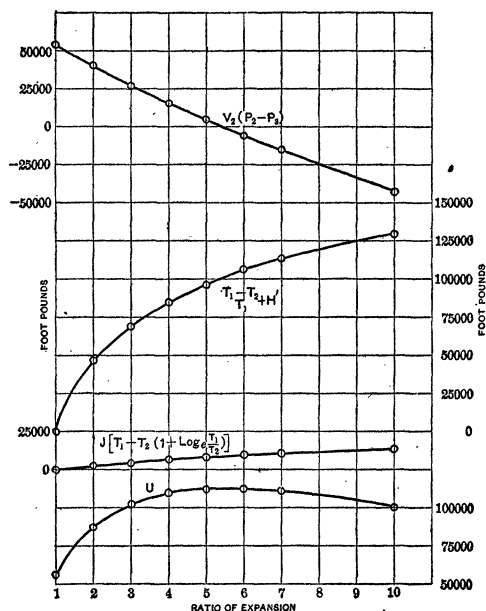
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per unit of working fluid, is secured at a loss of power per unit of heat supplied. It is still further to be seen that the greater, as well



WORK IN RANKINE CYCLES.

as the more economical, work-production is effected by the conversion of the so-called 'latent' heat of vaporization directly into mechanical energy or into work. It follows, still further, that the larger the quantity of 'latent' heat, the greater the work of a given weight of fluid and the lower the weight of water or other liquid per unit of power. Water has thus a double advantage in low expenditure per horse-power at a given temperature-range and efficiency of cycle, and in small, usually insignificant, cost.

These relations and the variations, especially, of relative magnitudes of the three terms with varying expansion-ratios from a given initial pressure, with, as is usual, constant back-pressure, in the ideal case, is well exhibited by the accompanying figure. This set of curves includes those of total work, of values of the several terms, and of relations of rate of variation, for such a case, in which the steam-pressure is about 7.5 atmospheres, the back-pressure one seventh that tension, and the ratio of expansion, ranging from unity upward,

in an engine which would be ordinarily rated at about 200 horse-power, at 85 revolutions per minute with  $r=4$ .

It is seen that the total work,  $U$ , increases rapidly from  $r=1$  to  $r=4$ , passes a maximum at about 5 and rather rapidly falls off again, after the expansion-line begins to intersect the back-pressure line (curve  $A$ ).

The work of sensible heat (curve  $B$ ) increases slowly throughout the range exhibited, and substantially in proportion to  $r$ , and is, throughout the whole range, small in comparison with the work of 'latent heat' (curve  $C$ ).

The work of the rectangular area below terminal pressure (curve  $D$ ) is similarly variable, but becomes negative at the point of junction of the expansion line with the back-pressure line. Throughout the whole usual range of expansion in the real engine, this quantity is small in comparison with that measuring the second term.

The value of the second term, on  $B$ , is thus the principal element of the total work of the cycle and is larger, relatively, as the diagram approximates the form of the Carnot, rather than the Rankine cycle. The deduction at once follows that 'latent' heat, and latent heat only, so far as practicable, should be utilized in the thermodynamic transformations of the vapor-engines.\* The 'latent heat fallacy' is thus clearly disposed of.

A similar investigation would show that, in the gas-engines, the 'latent' heat of isothermal expansion, rather than the sensible heat producing change of temperature, should be utilized in thermodynamic transformations and the production of power.

The final conclusion is thus obvious that maximum efficiency of thermodynamic engines can only be secured by the utilization, solely, of 'latent' heat.

R. H. THURSTON.

ON BACUBIRITO, THE GREAT METEORITE OF SINALOA, MEXICO.

For more than a century the meteorites of Mexico have attracted attention and record.

\* 'Manual of the Steam-Engine,' Vol. I., §112, pp. 437-438.

In his great work on 'La Nouvelle Espagne,' published in 1811, Humboldt described in a broad and philosophical way the great field of the Toluca Irons, and the size of some isolated masses in the States of Zacatecas and Durango. From that day until this naturalists and travelers in Mexico have examined and described this product of the country, commenting particularly upon their frequency and their size. Their frequency has been greatly overestimated. The total number credited to the Republic in Castillo's catalogue of 1889, was 27. To-day we know there are 32 distinct localities, omitting the several points embraced in two or three widespread showers.

Other areas of the same size as this Mexican belt in the United States and in India, give respectively 67 and 48 falls.

The preeminence of the Mexican meteorites is the vast size of many of them. In this matter of bulk they are unapproachable. Taking ten of the largest, we find their average weight to be  $9\frac{1}{10}$  tons. This as against  $8\frac{1}{3}$  cwt. as the average weight of the ten largest American meteorites.

The Mexican Government has taken an active and enlightened part in the protection of its meteorites. Twelve years ago it expended the sum of \$10,000 in bringing five of the largest of these to the capital, where they are mounted on huge iron pillars in the entrance court of the School of Mines.

The largest Mexican iron and one of the two largest meteorites in the world is in the State of Sinaloa, far in the northwestern portion of the Republic. This was first brought to the notice of the scientific world by Señor Marino Barcena, the noted Mexican astronomer, in 1876. In a ten-line notice of it to the Philadelphia Academy of Science, he says, 'I can assure the Academy that its length is more than twelve feet.' Castillo repeats this reported measure, adding its breadth as 2 meters, and its thickness as 1.50 meters. Brezina, Cohen and Wülfing speak of it as weighing 50 tons and as being the largest meteorite in the world. But in all this there was no definite description of the mass, and no one who mentioned it claimed to have seen it. We were anxious to ascertain about all this, to

find out the facts among many rumors. The Mexican savants were all interested in having this great celestial body investigated.

Through Señor José C. Aguilera, the Director of the Instituto Geológico, we obtained from the Minister of State letters to the Governor of Sinaloa and to the Director of Mines in that State. Western Sinaloa is practically impossible to reach in a direct line from the capital. The northern route through Arizona and Sonora involved a journey of over 2,000 miles. We took the shorter but harder route across the Cordilleras to the port of Manzanillo on the Pacific, and thence by steamer up the coast of the Gulf of California. There at the adjacent city of Culiacan we took a carriage with a four-mule team and an American photographer who accompanied us with his camera. A drive of 95 miles to the north and west took us in three days far up among the foothills of the Sierra Madre. Bacubirito is a small but very old mining town, situated on the road to Sinaloa in latitude  $26^{\circ}$ , and in west longitude  $107^{\circ}$ . The elevation above sea level is some 2,000 feet. The meteorite is seven miles nearly due south from there, near the hamlet called Palmar de la Sepulveda. Here we found it on a farm called Ranchito, which fills a narrow mountain valley between two spurs of the main range. It was there struck by the plow of Crescencio Aguilar in the summer of 1871. He soon uncovered enough of its bright surface to satisfy himself that he had found a silver mine! Its surrounding is now a cornfield with a black vegetable soil of some two yards in thickness. In this soil we found the great meteorite deeply imbedded. Its surface was but a little below the surface of the ground, but with one end slightly projecting above the level. It was a long, monstrous boulder of black iron, which seemed to be still burrowing to hide itself from the upper world. Its surface form was something like that of a great ham. We could walk for many feet along and across its surface, surveying these dimensions, but knowing nothing of how far the mass penetrated the soil beneath. Our first work was excavation. We soon got twenty-eight able-bodied persons for this. We undertook an area of thirty feet on a side,

with the great meteorite lying within. In a single day we passed down through nearly four feet of the soft vegetable soil, and the meteorite began to show in its entirety. The general form of the mass seen from the side was that of one ramus of a huge jaw. The surface was entirely covered with 'pittings,' very regular in size, and about two to three inches across; shallow, but with well-defined walls. There were no areas which showed the devastation of deep rust; a fact due both to the dryness of the soil and to the large alloy of nickel in the iron. On one side there was a deep crack, running horizontally through half of the mass. At its inception this crack was too narrow to insert a knife blade; at the other end it was nearly three inches wide. Our Mexicans were astonished at the result of their own labors; they marveled alike at the size of the mass and at our credulity in believing that it had ever fallen from space above.

By the end of the second day we had carried our excavation to an average depth of six feet. Over the area the vegetable soil was from three to four feet deep, while below it was a porphyry rock, common in this part of the country, much broken up by natural cleavages and decomposed *in situ*. Immediately around the meteorite we had dug much lower, leaving the great iron mass poised on a pillar or pedestal of the undisturbed rock. Finally we performed a feat of moving the great block. To lift one end with heavy tackle or machinery would have been impossible for us; but it needed little mechanical aid to make the mass move itself. We attacked with our long iron bars one side of the supporting pedestal. After long chiseling away one side of this, the center of gravity was reached, and, with a slow, almost dignified, movement, the great meteorite sank at one end and assumed a partially vertical position. Looking beneath it, we found that its late bed was a clean depression crushed into the rock, with absolutely no soil between it and the mass which had lain above it. It would thus *seem* that the meteorite had fallen on the bare rock surface of this district at a period before the vegetable soil had begun to form here. This would be

an interesting and astounding fact, carrying back the fall of our meteor to a remotely distant period, perhaps thousands of years. But there are other conditions which would need careful consideration before accepting so momentous a conclusion. The wonderful preservation of the mass, with its little oxidation, and the clean, sharp-rimmed pittings which cover its surface, seem to point to a more modern sojourn within the destroying influences of our air and moisture. We leave this for further consideration.

It is an interesting fact that this, perhaps the largest and heaviest meteorite yet discovered on our globe, should have fallen so near the present borders of our country. Interesting, too, that Mexico, with all its other extra large meteorites, should have received this champion mass. The extreme measures of Bacubirito, for so our meteorite from the first has been called, are:

Length .....	13 feet and 1 inch.
Width .....	6 " " 2 inches.
Thickness .....	5 " " 4 "

The form of the mass is extremely irregular, and though measures have been taken around the mass at many different points, its cubic contents can not be calculated with more than an approximation to accuracy.

The five largest meteorites known to science to-day, are:

Bendego (Brazil).....	5 1/3 tons.
San Gregorio (Mexico)....	11 1/2 "
Chupaderos (Mexico).....	15 2/3 "
Anighito (Greenland)....	50 "
Bacubirito (Mexico).....	50 "

The first three are weights proven on scales. The latter two are thus far simple estimates. How far estimated weights, based generally on simple guessing, may differ from *proven* weights is well illustrated by the case of Chupaderos. Fletcher, the noted mineralogist of the British Museum, says of it, 'According to one recent estimate its weight is 15 tons, according to another it is 82 tons.' Anighito, the great Greenland meteorite, has been guessed at all figures from 30 to 100 tons. A late unofficial estimate of it, after careful measuring, puts its weight at 46 1/3 tons. Should the Mexican Government, as some

expect, move the great mass, as it has done all the others, to the capital, its exact weight will be finally and definitely known. Whichever meteorite shall, after accurate calculation, prove to be the heavier, it will ever remain of interest that the two largest meteorites known to our earth should have fallen on the North American Continent; one far toward its northern end, the other toward its southern.

HENRY A. WARD.

#### SCIENTIFIC NOTES AND NEWS.

LORD AVEBURY has been made a member of the Prussian order 'pour le merite.'

DR. WILHELM WUNDT, the eminent psychologist and philosopher, celebrated his seventieth birthday on August 16. A volume of researches carried out by his former students was presented to him on the occasion.

It is announced from Berlin that the strength of Professor Virchow is unmistakably failing.

DR. EMIL TIETZE has been appointed director of the Imperial Geological Institute at Vienna.

AN international marine laboratory is to be established at Christiania under the directorship of Dr. Fridjof Nansen.

PROFESSOR ALBERT GAUDRY, the eminent paleontologist, has retired from his chair in the Paris Museum of Natural History, and has been made honorary professor.

A CABLE despatch to the daily papers from Samoa states that President David Starr Jordan was in serious danger owing to the capsizing of a boat, but was rescued by natives. He left for home on August 11. Dr. Vernon Lyman Kellogg, head of the department of entomology at Stanford University, who accompanied Dr. Jordan, has returned to the university.

ASTRONOMER WILLIAM H. WRIGHT, of the Lick Observatory, has been chosen to take charge of the D. O. Mills expedition, now being outfitted at Mount Hamilton, to spend two years in Chile in making special study of the stars of the Southern hemisphere. Director W. W. Campbell will go with the party to personally direct the erection of the observing

station and the beginning of the two years' astronomical campaign. Mr. Harold K. Palmer, fellow in the Lick Observatory, will act as assistant.

A REPORT on the occurrence of copper in the vicinity of Clifton, in southern Arizona, is being prepared by Mr. W. Lindgren, of the U. S. Geological Survey.

ONE of the three Royal prizes of the Accademia dei Lincei, at Rome, has been awarded to Professor Cantone, of Pavia, for his researches in the phenomena of elastic equilibrium outside the limits of Hooke's Law. The ministerial prize for mathematics has been divided into two prizes of 1,300 lire, awarded to Professors Giuseppe Bagnera (Messina) and Domenico de Francesco (Naples), and a premium of 700 lire has been assigned to Professor Michele de Franchis (Melfi).

DR. MAX WOLF has been appointed director of the astrophysical department of the observatory at Heidelberg.

DR. WILLIAM OSLER, of Johns Hopkins University, will deliver a memorial address on 'William Beaumont, the first and greatest American Physiologist,' under the auspices of the St. Louis Medical Society on October 4.

THE Berlin Academy of Sciences has granted 15,000 Marks to Professor A. Voeltzkow for an expedition to East Africa.

ON the occasion of his retirement from the curatorship of the Royal Gardens at Kew, Mr. George Nicholson has been presented by his friends with a suitably inscribed salver.

THE topographic branch of the United States Geological Survey will continue this season the mapping of the forested regions of Washington in the Cascades, under the general oversight of Mr. Richard U. Goode, geographer.

PROFESSOR BARBOSA RODRIGUES, director of the Botanical Garden of Rio Janeiro, is at present in England.

DR. CADY STALEY, who has retired from the presidency of the Case School of Applied Science after sixteen years of service, has gone abroad, where he expects to remain for several years.